



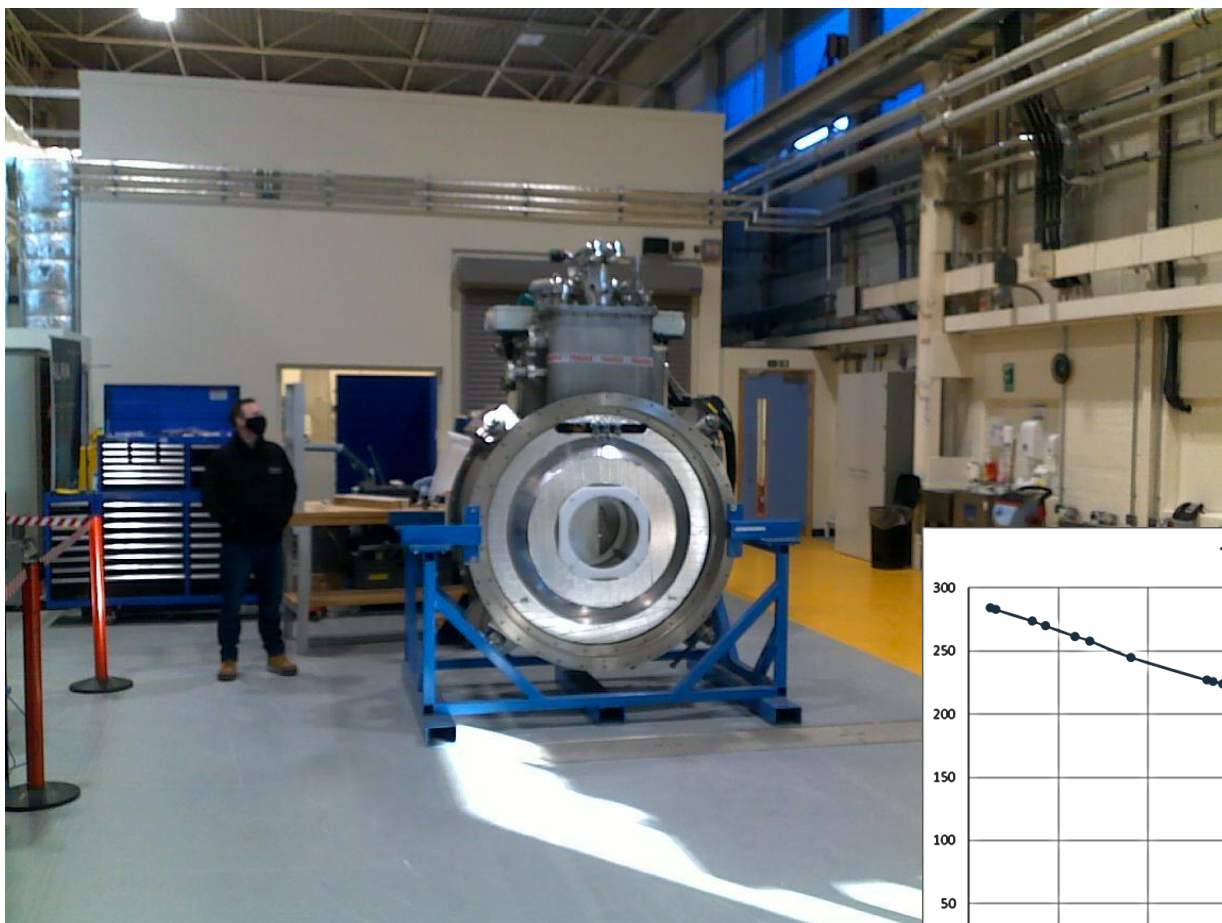
Technology Group

4T magnet

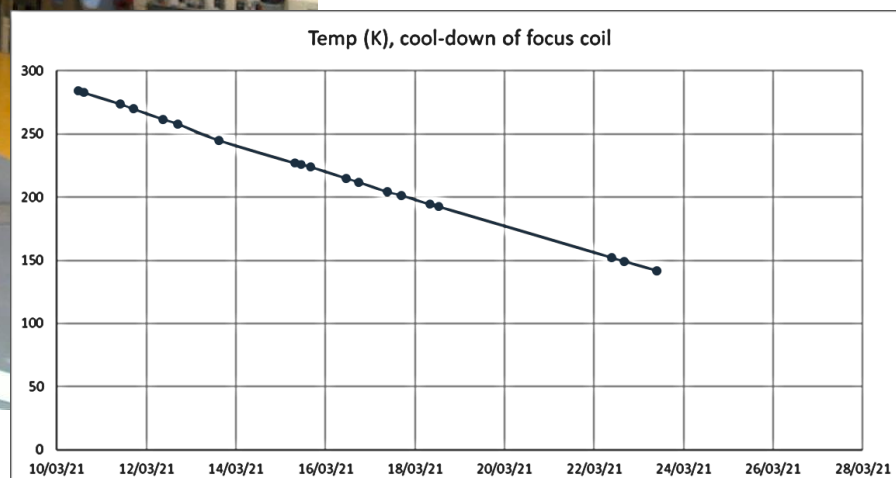
Josef Boehm
October 2022



Magnet commissioning at RAL

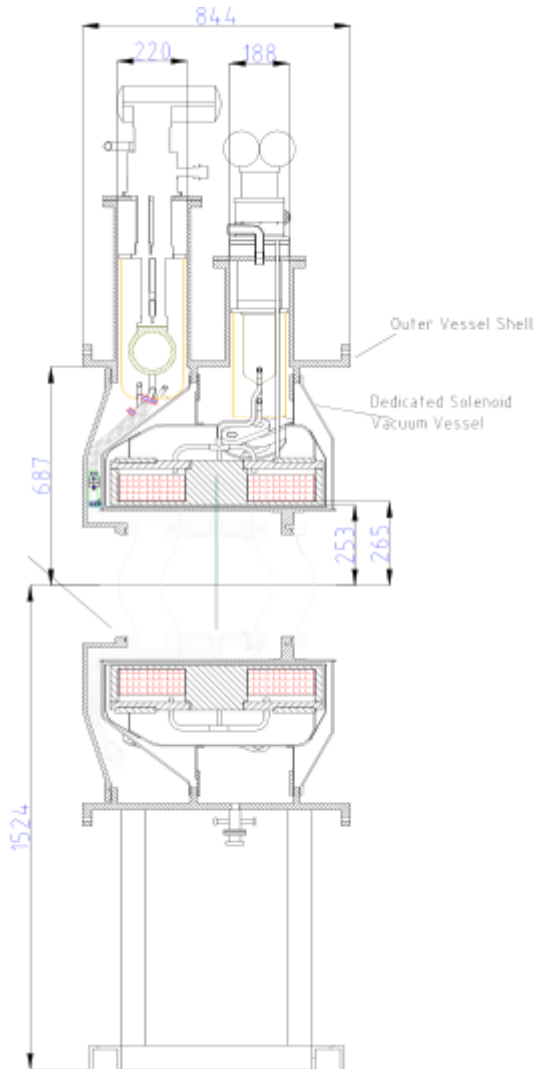




- Bore: ~450mm
- Field: 4T
- Solenoid or cusp mode
- 3rd cold head for sample cooling





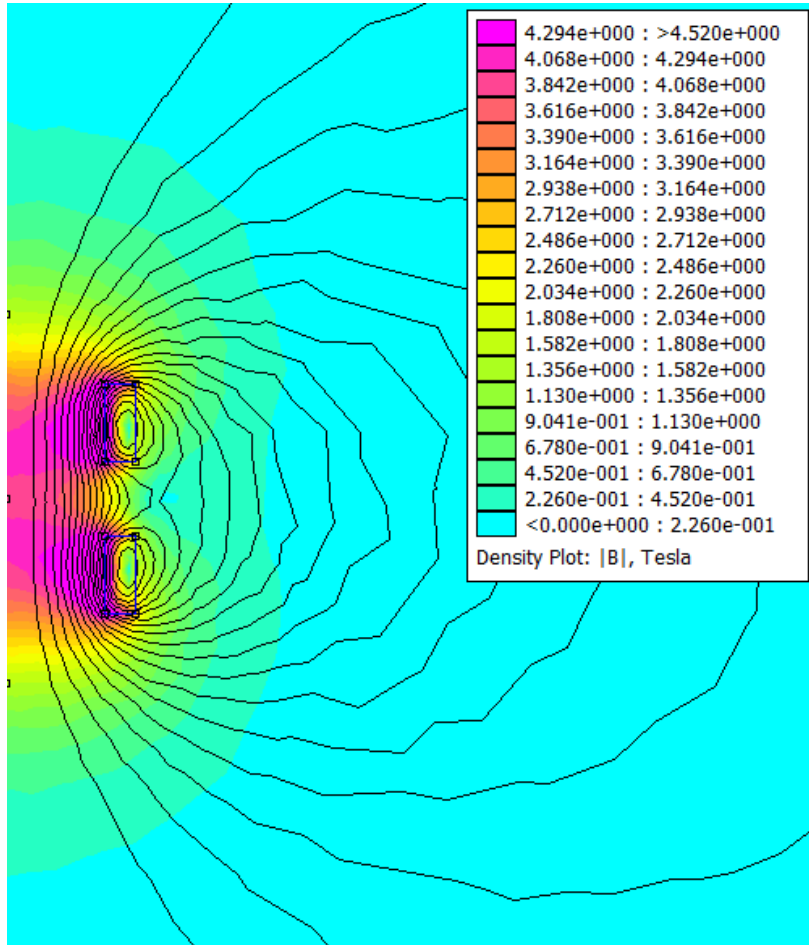
Magnet details



- Two internal coils, independent operation
- Modes: solenoid / cusp  
- In solenoid mode $\sim 4\text{T}$
- Bore diameter $\sim 470\text{mm}$
- Can take large horizontal forces
- $\sim 2\text{MJ}$, 100H, 180A, ramp-time: $\sim 1\text{h}$
- 2 pulse tubes & compr., 3rd PT for insert cooling
- Dry cool-down ~ 2 weeks, quicker with liquids
- Once cold the cryostat is zero boil-off



Magnetic flux lines

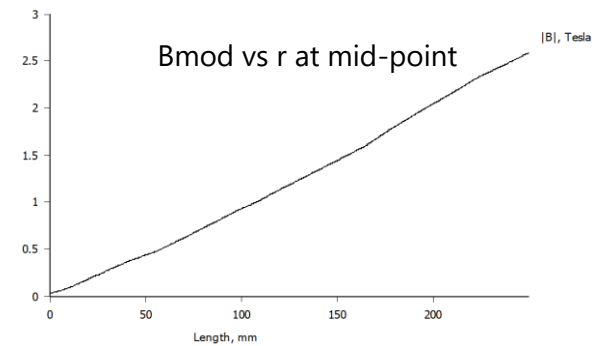
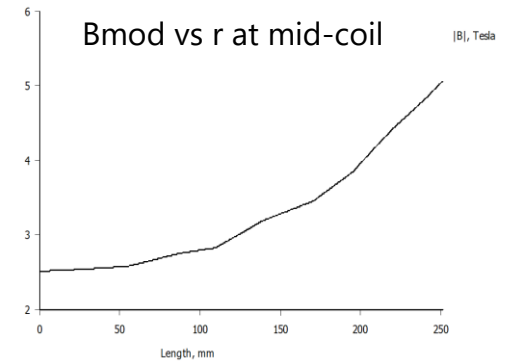
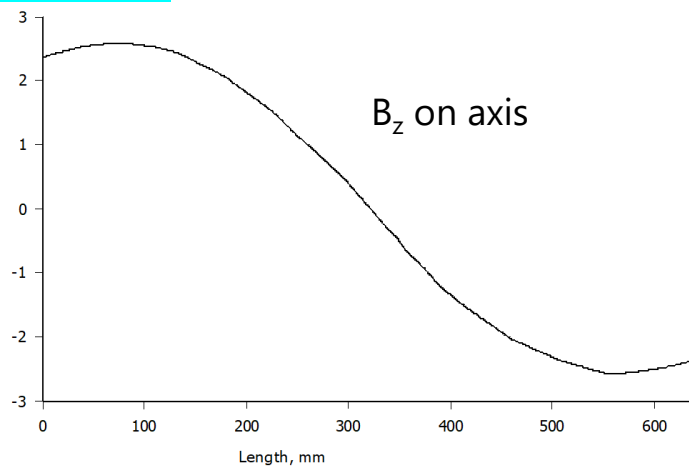
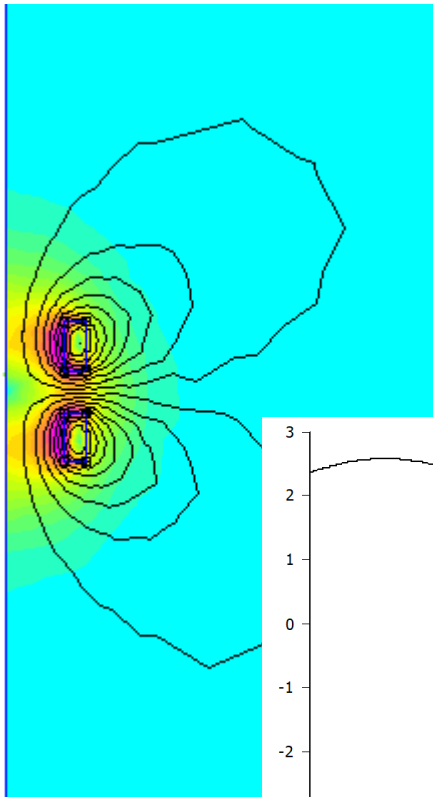


- Magnet in solenoid mode
- Centre flux density: 4T



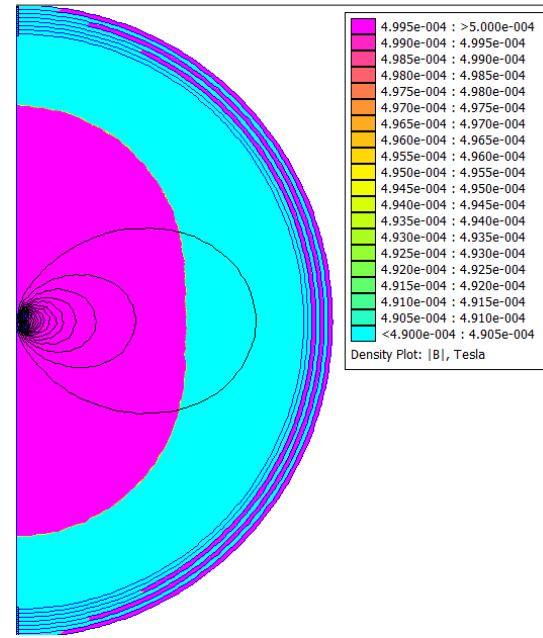
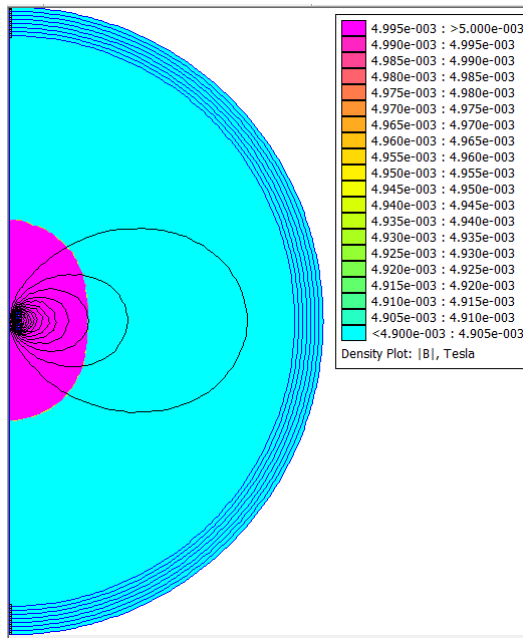
Coils in split mode (cusp mode)

- Coils driven with anti-parallel current
- Axial field lower ($\sim 2.5\text{T}$)
- High radial gradient field





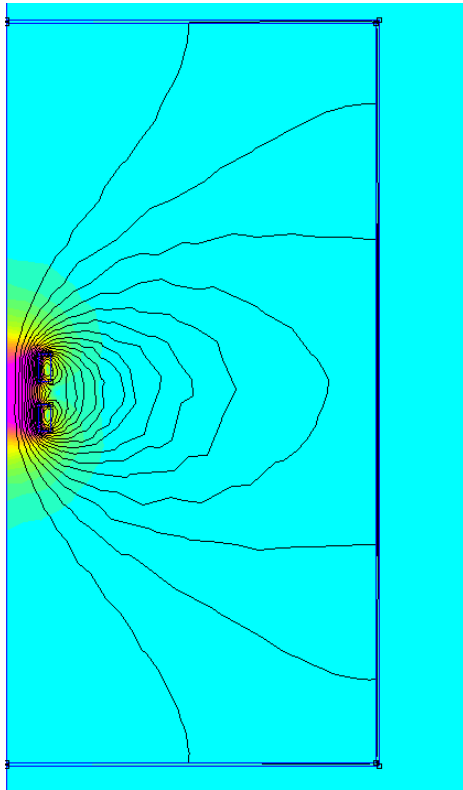
Stray fields (solenoid)



Stray field (4T setting) from magnet centre	@50G	@30G	@5G
Axial (m)	3.45	4.1	7.4
Radial (m)	2.7	3.2	5.9



Reducing the stray field



- Iron cladding on wall reduces extent of 5G-line from 5.9m to 3m (radial). This level can be optimised.
- Iron thickness here: 25mm
- Low carbon steel or silicon steel



Requirements to operate magnet

- ✓ Magnet in cryostat with two cryocoolers (pulse tubes)
- ✓ 2 compressors for PT's, Cryomech CP1000, 13 kW
- ✓ 20m gas lines

- Large building to operate the magnet, ~ 15m x 12m
- Control cabinet with PSU, temperature monitors, He-level monitor, switch gear
- Chilled water for compressors, ~ 15 – 20 l/min @ 15 degC
- Helium gas supply (gas cylinders), approx. 4 per run



Requirements to prepare the magnet

- The control cabinet will have to be assembled from existing and newly purchased components
- The quench protection circuitry will have to be assembled (resistors and diodes, on side of magnet)
- The magnet will have to be tested at RAL before shipment



A very coarse estimation of cost to restart an existing focus coil

Activity/Equipment	Effort	Material
FC magnet		£ 700k – existing
Checkout in UK	0.25	5k
QPS Refit		10k
Shipping		15k
Checkout in Paris	0.25	5k
Instrument Racks		100k
Cabling and sundries		10k